

**C**entre de **R**eferència en **E**conomia **A**nalítica

**Barcelona Economics Working Paper Series**

**Working Paper nº 61**

**Designing Decisions Rules for Transnational  
Infrastructure Projects**

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May, 2003

# Designing Decisions Rules for Transnational Infrastructure Projects

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**Barcelona Economics WP 61**

**Inter-American Development Bank**

Washington, D. C.

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May 2003

This publication can be obtained from:

IFM Publications  
Mail Stop W-0508  
Inter-American Development Bank  
1300 New York Avenue, N.W.  
Washington, D.C. 20577

E-mail: [sds/ifm@iadb.org](mailto:sds/ifm@iadb.org)  
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## Foreword

The Inter-American Development Bank has actively promoted infrastructure reform in Latin America. The Bank has also financed private projects aimed at fostering the implementation of reforms in the power, gas, water, and transport sectors. Now, the Bank is engaged in a program to develop transnational infrastructure projects.

Two regional initiatives were recently proposed to promote transnational infrastructure: the Initiative for the Regional Integration of South America (IIRSA in its Spanish acronym) and the Plan Puebla Panama (PPP) for Central America and Mexico. These initiatives face significant challenges, most of which have not been properly appreciated. This is because transnational projects have costs and benefits in several countries, with asymmetric distribution of those costs and benefits. These features of transnational projects raises new issues that do not appear in projects in which benefits and costs are mainly affecting a single country. One relevant issue is that under the condition of asymmetric distribution of costs and benefits, individual decisions made by one country do not result in optimal levels of investments in transnational projects. Lower than optimal transnational investment results from poor identification of the benefits of transnational projects, country reluctance to pay for infrastructure assets located abroad and lack of socially acceptable mechanisms to distribute costs and benefits among countries. Therefore, it may take a great deal of time for two countries to enter into a dialogue about a project with cost and/or benefits in both nations if they lack rules for cooperation and or incentives to communicate with each other about the project cost/benefits.

This article is part of the Inter-American Development Bank efforts to develop a conceptual framework for analysing transnational projects issues and developing solutions for dealing with them. The main message is to stress that the rules to take decisions strongly affect the performance of the partnership and that, consequently, attention should be given to their design at the initial stage. Moreover, partners must not only agree on how to take ordinary decisions, but also on how to take special ones, like that of changing the rules along the way, or that of modifying the membership of the group. Specifically, the paper discusses following points. First, the choice of partners is a key variable, which affects the choice of voting rules and in turn is also influenced by the conditions for new entries. Second, the choice of voting rules can crucially affect the degree of confidence and the level of cooperation.

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# Introduction

Partners in transnational infrastructure projects are engaged in long-term and complex relationships with numerous occasions for disagreement and conflict. Under the basic assumption that they expect sufficient benefits from working together, even if this means accepting some partial losses and occasional compromises, it becomes important to agree upon arbitration rules that would apply in case of conflict, rather than waiting for conflict to arise. The nature of the partnerships means that detailed contracts cannot be written because there is too much uncertainty and variety in the type of questions that need to be discussed. If the partnership is open-ended, the range of issues that must be decided can include additional projects, new entrants and other topics that extend beyond the scope of the original partners. Moreover, national sovereignty adds to the difficulty of letting a judge arbitrate on the basis of any detailed contract, even if one could be written.

The set of rules for making decisions in transnational projects conform to the project governance structure. Two essential features of transnational infrastructure projects are the need for a continued relationship among partners (as opposed to once-and-for-all deals), and the variability of issues involved in the relationship. Because of these features, governance issues in transnational infrastructure projects require a dynamic analysis in a different framework than that of traditional social choice theory. Intuitions and prejudices regarding what is a good voting system for making an occasional decision will fail dramatically when it's the dynamic consequences of the decision are taken into consideration.

Some rules that may appear to be good when making a single decision may be inappropriate when used for making decisions over time.

This article discusses the implications of decision rules in the governance structures of transnational infrastructure projects. It stresses that decision rules strongly affect the performance of the partnership and that, consequently, attention should be given to their design at the initial stage. The article also stresses the fact that partners must not only agree on how to make ordinary decisions, but also special ones such as, for example, changing the rules along the way or making changes to the membership of the group. This paper makes the following specific points. First, the choice of partners is a key variable, which affects the choice of decision rules and, in turn, is influenced by the conditions for new entrants. Second, the choice of decision rules can crucially affect the degree of confidence and the level of cooperation among partners, as well as the speed at which the partnership adopts new decisions. Third, agreements on how to eventually change the initial set of rules and partners should be part of the design of a well-established decision system.

Section 2 discusses the choice of partners in transnational projects. Section 3 establishes a model for analyzing decision rules and presents some basic results. Section 4 puts forward criteria for choosing among different decision rules. Section 5 examines the performance of partnerships under different decision rules. Section 6 presents recommendations and conclusions.

# The Choice of Partners

Partnerships in transnational projects are not forced upon participants, but they result from specific agreements to cooperate. In some cases, the choice of partners may be dictated by physical needs, like the exploitation of a shared river basin, for example. But, in most cases, physical constraints, even if always important, are not necessarily binding, and other considerations should enter the picture. These involve the complementarities among the parties, the availability of resources, the affinities in culture and management style, and the mutual trust, among others.

As a first approximation, we assume that each of the partners has made a ranking of the potential partnerships into which it would enter. This ranking may be based on considerations like those mentioned above, and summarizes the estimated costs and benefits of being part of each of the possible partnerships. For instance, a country 1 with excess capacity in electricity may be willing to interconnect its power network with country 2, which has a deficit, but not with country 3, which also has excess capacity and would be a competitor in selling electricity to country 2. However, country 2 may be willing to connect its system with both 1 and 3, in order to increase its supply of electricity.

## WHEN WOULD A PARTNERSHIP BE ACTUALLY CREATED?

Starting a partnership has financial and political costs for participants. Hence, it is important that potential partners believe that their association has a fair chance of holding together. This will partly depend on the alternative arrangements that each partner might enter into by joining other groups of countries to develop similar or competing projects. We model the trade-offs between these different alliances by assuming that each country has a preference ranking over the possible partnerships that can be formed. Given these prefer-

ences, one may discuss how likely it is that a partnership will hold together, taking into account each of the participant's alternative options. Our assumption is that a partnership will only be created if potential partners feel that it will not be easily broken. There are several possible ways to model the stability of partnerships; two of them will be discussed in this paper. Whatever the exact definition, we are concerned about the existence of stable partnerships, and also about the possible multiplicity of such arrangements.

*Existence* is relevant because lack of stability of a potential partnership is likely to result in the failure of the transnational project. Yet, there may be cases where, if the sources of instability are detected early, potential partners can change their initial positions and reach a stable compromise. *Multiplicity* is also an issue: when several stable partnership are available, the issue becomes to decide which one will be implemented in the end. The multiplicity of stable partnerships does not necessarily mean that any of the stable arrangements is equally desirable or equally likely. Stability is a property that stresses the ability of some arrangement to persist once they are reached. But reaching a cooperative agreement can happen in many ways, especially if some stable arrangements are better than others. Hence, the theoretical possibility of multiple stable partnerships is, in practice, an invitation to matchmaking: when there is room for several agreements, it is important to understand what additional factors can be put into play in order to arrive at the most favorable one.

Having now stressed that existence and multiplicity are theoretical questions with interesting practical consequences, let us be more precise about the type of partnership formation game that we have in mind, and the notions of stability that apply. By assuming that all that matters when determining an alliance is the partners that we join, we are restricting atten-

tion to purely hedonic games. In general cases, it may not only matter who my partners are, but also how other countries are grouped together into alternative (and possibly competing) partnerships. But hedonic games leave these other aspects aside to concentrate on those cases where what really matters most (actually, we assume that all that matters) is who are the partners: these are the so-called hedonic coalition formation games. Each potential partner has a preference ranking over the coalitions it can belong to. If  $i$  belongs to both  $A$  and  $B$ ,  $A \succ(i) B$  indicates that  $i$  prefers the formation of coalition  $A$  to coalition  $B$ . Coalition structures are partitions of the potential partners into mutually disjoint coalitions.

We now propose two possible definitions of stability. A coalition structure is said to be *core stable* if no set  $T$  of potential partners can become better off by leaving their initial coalitions in order to form  $T$ . When a coalition partition is not core stable, because some set  $T$

of agents would prefer to form, we say that  $T$  blocks the coalition structure. A coalition structure is *Nash stable* if no potential partner would prefer to join any of the existing coalitions instead of staying in the one where the structure places him. Each of these two definitions captures something relevant to the stability of a given set of partnerships. Core stability concentrates on the need to avoid coordinated, cooperative moves of different agents to form a new partnership. Nash stability takes a non-cooperative approach and prescribes that no agent should find it advantageous to unilaterally abandon its present partners to join others. Interestingly, these two types of stability are independent: one can be guaranteed when the other is not. Examples 1 and 2 exhibit situations where one form of stability is achieved and the other is not. Ideally, one would be interested in forming partnerships in contexts where both types of stability hold. Yet, there may be cases when none can be achieved! This is described in example 3.

**Example 1\***  
***An Undesired Guest. Core Stability Without Nash Stability***

There are three countries that are considering integrating their power transmission networks. Country 1 and country 2 have similar internal regulations and sector structures, while country 3's sector structure is a public monopoly producing and distributing electricity. Countries 1 and 2 wish to integrate their network to increase sector competition and efficiency. However, they refuse to integrate their network with country 3 because they suspect that country 3 will compete unfairly. Country 3 wishes to integrate its network with countries 1 and 2 in order to increase its potential market. Formally, these preferences may be represented as follows:

- Country 1 Preferences:  $\{12\} > \{1\} > \{123\} > \{13\}$
- Country 2 Preferences:  $\{12\} > \{2\} > \{123\} > \{23\}$
- Country 3 Preferences:  $\{123\} > \{23\} > \{13\} > \{3\}$

The core partnership is  $\{12\}$  because no other coalition yields a better outcome for countries 1 and 2. However, it is not Nash stable because country 3 would prefer joining 1 and 2, rather than staying alone.

\*The example is drawn from Bogomolnaia and Jackson (2002). It has been slightly modified to put it in the context of transnational projects.



### Example 2\*\*

#### *Company is Good, but Two Are Better than Three. Nash Stability Without Core Stability*

Three countries are considering whether to integrate their power transmission networks. The sector structures of the three countries consist of one integrated public monopoly. The countries wish to integrate their power networks in order to reduce the variable cost of producing electricity and to increase the security of the system. System security increases with the integration of two countries' networks, but it decreases when a third country is added. However, system stability is better under three-country integration than with isolated countries. Therefore, the three countries prefer two-country integration to three-country integration, but they prefer three-country integration to remaining isolated. However, countries do not have compatible preferences on how to integrate. Country 1 prefers integration with country 2 to integration with country 3, while country 2 prefers integration with country 3 to integration with country 1, and 3 prefers 1 to 2. Formally, these preferences may be represented as follows:

Country 1 Preferences  $\{12\} > \{13\} > \{123\} > \{1\}$   
Country 2 Preferences  $\{23\} > \{21\} > \{123\} > \{2\}$   
Country 3 Preferences  $\{31\} > \{32\} > \{123\} > \{3\}$

In this example, there is no core stable coalition structure, but  $\{123\}$  is the unique Nash stable arrangement

\* \*\*The example is drawn from Bogomolnaia and Jackson (2002). It has been slightly modified to put it in the context of transnational projects.

### Example 3

#### *Two Is Company, Three Is a Disgusting Crowd. A Case for Instability.*

Three countries are considering whether to integrate their power transmission networks. The sector structures of the three countries consist of one integrated public monopoly. The three countries wish to integrate their power networks in order to reduce the variable costs of producing electricity, and also to increase the security of the system. System security increases with the integration of two of the countries' networks, but it decreases when a third one is added. Therefore, the three countries prefer two-country integration to three-country integration. In fact, isolated networks are more secure than three integrated networks. Countries do not have compatible preferences on how to integrate. Thus, country 1 prefers integration with country 2 over integration with country 3, while country 2 prefers integration with country 3 over integration with country 1. And 3 prefers 1 rather than 2. Formally, these preferences may be represented as follows

Country 1 Preferences  $\{12\} > \{13\} > \{1\} > \{123\}$   
Country 2 Preferences  $\{23\} > \{21\} > \{2\} > \{123\}$   
Country 3 Preferences  $\{31\} > \{32\} > \{3\} > \{123\}$

In this third example, no coalition structure is either in the core or Nash stable.

\*\*The example is drawn from Bogomolnaia and Jackson (2002). It has been slightly modified to put it in the context of transnational projects.

The foregoing discussion suggests that even beneficial partnerships may be unstable in the presence of alternative and competing possibilities. Whether or not this is a real threat to the emergence of partnerships will depend on the actual options open to different partners. The literature on hedonic games describes a number of situations where the preferences of players will guarantee the existence (and sometimes the uniqueness) of stable partnerships. Let us briefly discuss two of them. The first one is called the weak top-coalition property, and it expresses the existence of a fair degree of unanimity among potential partners regarding what arrangements are most desirable, combined with a dose of realism (See Banerjee et al. for more formal definitions and results). Consider all potential partners, and assume that a group of them,  $S_1$ , is such that all its members consider  $S_1$  to be their best choice. These people are obviously happy if they are together, and want no additional partners. Now suppose that there is a second group,  $S_2$ , whose members agree that  $S_2$  is the best group they can reach, once they admit that no member in  $S_1$  will join them. Further assume that there is another group,  $S_3$ , which is the best group for all its members, as long as they admit that no one from  $S_1$  or  $S_2$  will join them, and that this pattern continues for a list  $S_1, S_2, S_3, \dots, S_k$ , until all potential partners are taken into account. If preferences of agents are of this sort, then there will always exist core stable allocations. How likely is it for a set of potential partners to meet the weak top-coalition property? The answer to this question depends on the nature of the transnational project at hand. The essential feature is that one group should exist such that no partner is inclined to include anyone else that others consider harmful, and that no partner should receive offers from another group that may be better. As presented, this is a condition of unanimity and realism (we are the best possible group, once we discard the unreachable partners). In many cases, potential partners for transnational projects may reach situations of this nature, at least after having tried a few alternative possibilities and having adapted their preferences to reality.

Bogomolnaia and Jackson (2002) also discuss a parallel property to guarantee the existence of individually stable partnerships. They are a combination of two requirements called  $\alpha$ -ordered characteristics and consistency. We leave it for the interested reader to go into the details, and just provide an example where existence would be guaranteed. This is the case where potential partners only care about the size of the partnership they will be a part of, and their preferences about size are single peaked. This means that each partner can still have a range of different preferences: some may be for small groups, some for large ones. What they have in common is that, whatever size they prefer, they will find smaller partnerships to be worse the smaller they are, and partnerships that are larger than the ideal size will be worse, the larger they are. This condition is enough for individually stable partnerships to exist. Again, we may ask, when is this likely to hold in the context of transnational projects? We believe that the condition will not hold in projects where partners' contributions are very asymmetrically, since the number of partners may not be nearly as significant as their quality. However, it may hold quite approximately in other cases where the main reason to contribute is to share some common costs and benefits. Then, a larger partnership may be better than a smaller one, as long as this results in a decrease in the individual's share of the cost. A larger partnership may also be a stronger one. But, of course, coordination problems and other difficulties associated with size may work in the reverse direction of decreasing some of the benefits, while introducing costs of a new type. The peak of each country's preference would reflect its estimate of the optimal size, in view of such considerations.

We have thus seen that stability of both types may or may not hold, depending on the circumstances. In particular, the nature of the benefits to be gained, and of the costs to be shared is crucial. In many practical situations it may be that those sufficient conditions for stability do hold for a wide class of transnational projects, especially if the superiority of certain arrangements becomes clear for all

interested parties, and/or if the possible deals exhibit sufficient symmetry among parties. A final warning is in order. We have discussed stability issues in the context of purely hedonic games. Other types of games have been studied in the literature on coalition formation, allowing for partners to simultaneously negotiate on whether to join, and also on possible internal compensation schemes. The choice of model was made in order to emphasize the dangers of instability within a simple framework. There is no doubt that a richer framework may give hints in further directions, but we hope that the point about stability is sufficiently made.

### WHEN TO ACCEPT A NEW PARTNER?

Changes in the number of partners should be expected in any partnership. Partnerships must have rules allowing some partners to expel others under exceptional circumstances, or partners to leave the group under certain conditions. Dissolving the partnership is also an extreme action that must be contemplated. Similarly, partnerships must have rules for accepting new partners. We concentrate here on the question of admission of new members to an already existing partnership. The main conclusion of the analysis is that the rules for expansion must be part of the initial negotiation among the founders of the partnership because they can play an important role in deciding whether or not to form it in the first place. This role may be positive or negative, and depend on the rules adopted for expansion. But it certainly should not be ignored, and it has an essentially dynamic character.

Consider a set of partners that have already agreed to cooperate and want to set rules for possible future expansion. They have to consider the potential set of future entrants,

or candidates, and evaluate the impact of each entry. On a first analysis, what a new entrant brings into the partnership may be similar to the contributions of already existing partners. Hence, we may assume that each founder can appraise whether the entry of a new member is or is not desirable, and to what degree. For simplicity, let us assume that the desirability of each new partner can be judged independently; in practice, there may be complementarities. Would this appraisal be sufficient to predict, given an admission rule, which new partners would be invited to enter? Not necessarily, if we consider the full consequences of an admission decision over time.

Indeed, the admission of a new partner has a double consequence. Existing partners enjoy (or suffer) the consequences of a new member in the partnership. However, the new partner also has voting power and this may substantially alter the overall evaluation of new entrants at any given point in time. Thus, a candidate for entry may be attractive as long as he does not get the right to vote, but become unattractive if given voting rights because, say, he is known to have leanings toward further admissions that may be unattractive to the existing partner considering his admission. This may lead that existing partner to prefer a postponement of membership expansion, at least until a time when such an expansion looks less threatening. Notice that this phenomenon only occurs if the decisions taken by the founders involve the entry of new members who get a voice, and within a multi-period context where this new voice can have further consequences. It would not occur if the decisions involved new projects rather than new partners, or even if the partners were recruited toward the end of the joint venture, with no ability to influence future membership.

**Example 4**  
***Unanimity Rule Versus Majority Rules For Accepting Partners***

Consider five country founders who have agreed to integrate their electricity markets and to develop the required transmission network. They have also agreed on a rule that requires that at least five of the original partners endorse the entry of a new country into the group.

*How does this rule perform, if we compare it with one that only requires three favorable votes?*

Assume that each of the new candidates favors the entry of additional countries, which they will try to push into the partnership once they are in. Suppose that they have enough supporters within the founders to eventually force the admission of these additional countries if the rule is three, but that they will never be able to get five votes for the new candidates. Then, those founders that would be ready to vote for the original candidate, but prefer the expansion to stop there, may accept the newcomer under the rule of five (the one that allows them to block further entry). But they would not support the newcomer under the rule of three because this would start an undesired second round of admissions.

Once we consider this double effect, it becomes clear that the choice of admission rules for future partners is a nontrivial matter (see Barberà et al., 2001; Barberà and Perea, 2002). A more conservative rule that preserves some degree of control over future events, may end up facilitating a faster growth of the partnership than an apparently more lenient admission rule. In fact, a similar effect will occur when we consider the dynamic effects of other decisions, provided that we do not treat them as one-shot decisions, but that we pay due attention to the way in which they unfold over time. This is the subject of Section 4.

In order to emphasize the importance of setting the expansion rules from the beginning, I will just mention some of the strategic activities that partners can engage in and whose consequences may differ depending on

the expansion rule adopted. First, notice that logrolling phenomena are to be expected when the admission of new members requires more than one vote: you may support an entrant who is important for your partner in exchange for your partner's support of the entry of someone important to you. Second, you may accept a new entrant not because of your expectations about new entrants, but to get the support of partners on other issues of interest to you, including further admissions. Third, strategic behavior may appear even in cases in which only one vote is required for new entry.<sup>1</sup> Again, discovering the theoretical possibility of such strategic interactions remind us that, when negotiating the initial arrangements for a partnership, we should not forget that expansion rules are an important aspect of the initial negotiation.

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<sup>1</sup> In the Appendix we provide an example of a different type of strategic behavior, which arises even in the case where one vote is sufficient for new entries.

# The Preferences of Partners Over Decision Rules: A Basic Model

This section describes a simple model to analyze why different agents may have different preferences about the rules to govern joint decisions. The model is taken from Barberà and Jackson (2000), and follows a tradition started by Rae (1969). In spite of its simplicity, it allows us to understand different aspects regarding the choice of a choice rule. In particular, it allows us to derive (rather than to assume) the preferences of partners over qualified majority rules.

## THE MODEL

We consider the following model. There are  $n$  partners, who will face a sequence of decisions involving, in each case, only two possible courses of action. One of them we call the status quo, and the other we call change.<sup>2</sup> Each partner  $i$  is characterized by a parameter  $p(i)$ , between *zero* and *1*, to be interpreted as the probability that the partner gives to being in favor of change if presented with a particular binary choice. Hence, an agent would have  $p(i)=1$  if he was sure to always favor change. In order to avoid trivial cases, we assume that 0 and 1 are excluded values for  $p(i)$ . Yet, an agent with  $p(i)=.9$  will be someone very likely to favor change, and  $p(j)=.01$  will stand for someone that only rarely wants change.<sup>3</sup> We also assume that their values are common knowledge to all partners, and that the specific random draws that determine whether an agent is for or against change at each decision moment are independent from one agent to the other.

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<sup>2</sup> Both proposals will imply change in most cases. However, in order to avoid cycles, at any point in time partners face only two alternatives

<sup>3</sup> Possible changes to enrich this simple model will be discussed in Section 6, about extensions and conclusions.

We assume that all partners derive satisfaction when the social decision coincides with their vote, and not otherwise, and that their utilities are additive. Votes will be non-strategic, because they only involve separable yes/no decisions. We treat all issues as equally important, and normalize utilities to one, every time that the partner gets his way, and zero when he doesn't.

Each qualified majority rule is described by a single parameter  $s$ , between 1 and  $n$ , which determines the amount of support that is required for the partnership to adopt change. Hence,  $s=1$  corresponds to the case where the favorable vote of a single partner is enough to precipitate change, while  $s=n$  stands for the unanimity rule: only changes that everyone supports will be adopted. Simple majority is the case where  $s=(n+1)/2$ , when  $n$  is odd, and  $(n/2)+1$ , when  $n$  is even.

A simple calculation enables us to compute the preferences of each partner on the different values of  $s$ , given the pattern of the  $p(i)$ 's across different partners. For each decision rule  $s$ , agent  $i$  gets utility one if change is enacted and she agrees with change (situation a), or if she is against change and change is not adopted (situation b). The probability of *situation a* is given by the probability that at least  $s-1$  of the other partners want change, times the probability that  $i$  wants change. Likewise, the probability of *situation b* is given by the probability of, at most,  $s-1$  of the others want change, times the probability of  $i$  not desiring it. The expected utility of agent  $i$  under rule  $s$  can be calculated as follows. It is the sum of these two probabilities times the utility that  $i$  obtains from them (which we assume to be one), plus the complementary probability times the utility of society making the decision that agent  $i$  does not favor (which we assume to be zero). Hence, in our case, the expected

utility for individual  $i$  of society's decision to use rule  $s$  will be equal to the probability of  $i$  finding that her desired decision coincides with that of society<sup>4</sup> (which, as we have seen, depends on  $s$  in a very neat way).

### SOME RESULTS

A *first result* is when all partners have the same probability of favoring change, that is, when  $p(i)=p(j)$  for all  $i$  and  $j$ , then all partners have the same preferences on decision rules. Moreover, they all agree that simple majority is their preferred rule. This gives simple majority a salient status, as the unanimous choice in homogeneous societies.

This fact is not hard to argue, but notice that it is far from intuitive. If you ask people about the preferred rule for a partnership whose members are averse to change (with  $p(i)=.1$ , say), and for another partnership of change lovers (with  $p(j)=.9$  for all), the tendency is to assume that the more conservative partnership will favor a more conservative rule, that is, a higher  $s$ , than the one that is pro change. Yet, this is not true. In both cases partners will agree, by unanimity, to choose the simple majority rule. This is because what matters to each partner is how often he will be on the winning side, and in a homogeneous society it is always more likely to be in the larger than in the smaller group, for any partition. Of course, the society where all agents have  $p(j)=.9$  will find itself more often in favor of change than the one where agents favor change with  $p(i)=.1$ . But in both societies all agents will agree that simple majority is the best rule.

Notice that the preferences of any partner for different decision rules depends on her atti-

<sup>4</sup> We have described it for the case where the probabilities for each individual to be for or against change are independently distributed, and where the agent's utilities are zero or one. We could complicate the model by assuming that the probabilities are not independent, and also by assuming that partners care about different issues with different intensities. But our qualitative statements would not change.

tudes toward change as well as on the attitudes of others. One cannot, a priori, determine whether a partner will favor the use of a high or of a low majority by just knowing her willingness to change. One must also know the willingness of others to change. What matters is not the absolute value of  $p(i)$ , but its position relative to the  $p$ 's of other partners.

A *second result* is that, when agents have different  $p$ 's, then the preferred rules for different agents are ranked in inverse order than their  $p$ 's. That is, if  $p(i) > p(j)$ , then  $s^*(i) < s^*(j)$ , where  $s^*$  stands for the most preferred rule for the corresponding agent. In simple words, the partners who are more pro change will tend to favor rules that make change easier, by demanding a smaller fraction of the population's vote to pass change.

The next two results will prove to be important when discussing the possibility that partners might choose their decision rule by means of a previous vote.

The *third result*<sup>5</sup> is that, for any partner  $i$ , and whatever the distribution of  $p$ 's among partners, the preferences of all agents over voting rules will be single peaked. That is: each agent will have a best voting rule  $s^*(i)$  (exceptionally, in our model there may be two contiguous ones), and if rule  $s > s' > s^*(i)$ , or  $s < s' < s^*(i)$ , then  $i$  prefer  $s'$  to  $s$ .

The *fourth result* says that the preferences of all agents satisfy a condition of intermediate-ness. If two agents agree on how to rank a pair of rules, then all the other agents whose position in terms of  $p$ 's is intermediate between the two also rank  $s$  and  $s'$  in the same way. Consider that agent  $i$  and agent  $j$  both prefer voting rule  $s$  to voting rule  $s'$ , and that  $p(i) < p(j)$ . Then all other agents  $k$  such that  $p(i) < p(k) < p(j)$  will also prefer rule  $s$  to  $s'$ .

<sup>5</sup> Single peakedness is a very well known concept, first introduced by Duncan Black (1948) in the theory of voting more than fifty years ago. The notion of intermediate preferences is due to Grandmont (1978).

Taken together, the two results above prove that the preferences of agents over different voting rules are well behaved. In particular, single peakedness and intermediateness, each by itself, are sufficient to guarantee that there exists a rule that would defeat all others in

pairwise majority contests. Hence, one could organize the initial choice of rules as a majoritarian election with no fear that cycles would result. In the next section we shall discuss other considerations that may lead a partnership to choose one rule over the others.

# The Choice of Rules and How to Change Rules

Knowing the preferences of partners regarding voting rules may allow us to predict which one will be chosen to govern their relationships, or to discuss from a normative point of view which rule should be chosen. There is not one single and definite answer to these questions. Let us discuss several competing approaches.

## VOTING RULES FOR EFFICIENCY

A criterion for choosing a voting rule may be to select the one that guarantees the maximum total utility to partners. In the simple model we described in the previous section, the rule of simple majority has some permanent features that distinguish it from the other majority rules: it is the one that guarantees the maximum aggregate utility. To see this, remember that the utility of each agent equals the probability of finding herself on the winning side; that is, of seeing change when she favors change and stopping change when she does not want it to occur. Since simple majority maximizes the number of partners who can feel that they got their way after each voting decision, it is the most efficient rule in the utilitarian sense.

A similar reasoning allows us to understand that efficiency may require other types of voting rules under alternative circumstances. If different partners care for different issues with different intensities, then we will have to look for a different balance. We will have to compare the probability of being on the right side with the importance of the issues for which one may find oneself on the wrong side. This can lead to the choice of different rules than that of simple majority. Yet, in a world where one does not know a priori what the issues will be, how opinions will be split between partners, and whether disagreements will entail minor or major issues, it may be a good idea to stick to our model because it treats all cases symmetrically. Under these conditions, simple majority emerges as the favorite rule on effi-

ciency grounds (for details, see Badger (1972), Barberà and Jackson, 2000).

Different and more complicated questions arise if the size of the countries or the intensity of their interest in the project does matter as far as the partnership is concerned. In transnational partnerships some of the members may represent much larger populations than others, or may derive much higher benefits from co-operation. These are factors to be taken into account, and which may lead some of the partners to demand a larger number of votes than those assigned to others. In section 6 we briefly discuss some of the grounds on which these distinctions may be justified, the extent of the admissible differences and the implications of assigning a different number of votes to different partners.

## DECISION RULES FOR FAIRNESS

Let us now turn our attention to a different normative criterion. The members of the partnership may agree to choose that rule which maximizes the expected gain of the least fortunate partner. This position is associated with a notion of fairness, or egalitarianism, and is called the *maximin criterion*. Typically, the use of this criterion in order to choose a rule will not lead to recommend a simple majority.

We have already mentioned that the partners' preferred rules (the peaks of their preferences) will be ordered in such a way that the most conservative agents will favor the higher size majorities (all this in relative terms). Start by considering the peak of the agent with a higher  $p$ . Say that it is at majority size  $s$ . This will be the lowest among the majority sizes where some agents would not wish to see the majority size increased, while others will. Consider now the next higher majority rule,  $s+1$ . The partners whose peak was at  $s$  would lose utility if  $s+1$  was chosen, relative to  $s$ , while other agents would gain utility. Going to  $s+2$



will again decrease the utility of agents with peak at  $s$ , and also that of the (possible) partners with peak at  $s+1$ , while still increasing the utility of those with peaks above  $s+1$ . By continuing this process until we get at the peak of the agent with a lower  $p$ , we are thus generating a sequence of utilities for the different agents, with the following characteristics. The worse treated agent at the beginning of the sequence is the agent with the lowest  $p$ , and her utility keeps increasing along the sequence. The agent who is treated best at the first step of the sequence is the one with the highest  $p$ , and her utility keeps decreasing along the sequence. Moreover, one of these two extreme agents is the worst treated all along the sequence. Hence, the maxmin criterion recommends choosing the rule where the utilities of these two agents are more equalized. In general, the maxmin criterion will choose a majority size different than simple majority. The choice of these rules is almost unique, and it can always be made compatible with ordinal Pareto efficiency, though it typically will not lead to surplus maximization (see Coelho, 2002).

#### A TWO STEP PROCESS

The choice of rules by means of a normative criterion can be viewed as the outcome of a two-step process. At a first stage, agents would try to agree on general principles, like maximizing the sum of utilities or ensuring fairness. The choice of principles may be reached by unanimity among partners or may reflect the decision of promoters. Efficiency would be the most likely criterion to guide partnerships for developing transnational infrastructure projects. However, since transnational infrastructure projects are promoted by multilateral agencies; implications on income distribution are also usually taken into account. Therefore, some sort of fairness criterion should be included in the partnership. Having reached an agreement on general principles, partners can then establish, in a second step, the rule that satisfies those principles (taking their particular circumstances into account). If they agreed on efficiency only, then they should agree to use simple majority. If they agreed on egalitarianism, then they should select the rule that maximizes the utility of the partner that reaps the least benefit from this choice of rule.

tarianism, then they should select the rule that maximizes the utility of the partner that reaps the least benefit from this choice of rule.

Thus, in addition to its normative meaning, the choice of rules (according to the utilitarian or to the egalitarian criterion) can be viewed as predictions of possible consensus positions, if the partners are bound to choose the voting rule by unanimity. Even if they were not operating under a veil of ignorance, but aware of their differences, they may put them aside and agree upon a general principle like the ones mentioned above.

#### CHOOSE HOW TO CHOOSE DECISION RULES THROUGH A VOTING SYSTEM.

An alternative view to that of choosing principles is to take into account that decision rules themselves are also chosen by vote. Consider, then, that partners will vote on how to vote. In order to avoid circularities we set the problem in the following terms. Society already has a rule in place, which is used for everyday decisions. Now we can ask whether it is a good idea to use the same rule or a different rule to decide whether to shift from the current rule to any other one.

If we decide to use the same rule that is used to adopt ordinary decisions, problems may arise when the time comes to debate whether we should change rules. To see that, say that a majority size  $s$  is self stable if less than  $s$  partners want to change to another rule  $s'$ , for any  $s'$  different from  $s$ . In that case, no proposal to change the rule away from  $s$  would be passed, according to the  $s$  rule. Unfortunately, we cannot be sure that there will always be a self-stable rule. This will depend on the distribution of the partners' willingness to change. We have already mentioned that when all partners have the same  $p$ 's, then they all agree that simple majority is the best rule. However, there are situations where no self-stable voting rule exists. Example 5 shows a case in which no stable rule may be found.

In view of that difficulty, it makes sense to endow partnerships with two rules, rather than one. One of the rules would be used for everyday decisions, and the other for changing the rule of everyday decision. The latter should be chosen in a way that guarantees overall stability.

Let introduce the concept of a constitution, as defined by two decision rules,  $(s, S)$ . These rules may be interpreted as follows:  $s$  is the rule to be used for everyday decisions, while  $S$  is the rule to be used to change  $s$ . Say that a constitution  $(s, S)$  is self stable if no rule  $s'$  can beat  $s$  by  $S$  or more votes. Contrary to self-stable voting rules, self-stable constitutions always exist, irrespective of the partners' willingness to change. Which ones will satisfy this property will depend on the distribution of  $p$ 's, in general terms. But one combination is always self-stable, for any distribution. It is the constitution with  $s$  is simple majority rule and  $S$  is unanimity rule. This is because our model

implies that, for all societies, if some voters prefer a rule lower than simple majority, then some others will prefer a rule higher than simple majority. Hence, there will never be a unanimous direction of departure away from simple majority. Also self stable for each given distribution is the constitution where  $s$  is the median of the distribution of the partner's preferred rules, and  $S$  is larger than simple majority. This is because (by the definition of the median) one cannot get more than half of the population to agree on lowering the rule below the median, or to agree on increasing it above the median (see Barberà and Jackson, 2000).

Partnerships should take these remarks into account when selecting their own rules, and decide whether they prefer to establish a guarantee of stability by distinguishing between standard voting rules for everyday business and a constitutional rule to change rules.

#### **Example 5** ***No Stable Decision Rule***

The partnership consists of five countries that are engaged in developing a rail network. They have an initial project to develop the transnational infrastructure over 10 years. Nevertheless, they wish to establish a rule for accepting or rejecting modifications to the initial projects. Countries 1, 2, and 3 have similar preferences. After analyzing the expected modifications to be considered, the three countries believe that the probability of accepting a change will be 50 percent. These subjective probabilities may be seen as derived from the expected benefit that the country will receive with the corresponding modification. The other two countries will be more reluctant to approve modifications and they have a lower probability of accepting a modification. Formally, partners have the following probability of voting a change:

- $p(1)=p(2)=p(3)= 1/2, p(4)=3/8$  and  $p(5)=3/16$

Using the simple model of the previous section, we can conclude that countries 1, 2, and 3 would prefer to establish a rule that allows for a modification when two countries favor it, country 4 prefers a rule requiring 3 votes for accepting changes, while country 5 demands 4 votes before accepting them. Formally, the preferred rules for the countries are:

- $s^*(1)=s^*(2)=s^*(3)= 2, s^*(4)=3$  and  $s^*(5)=4$ .

To verify that there are no self-stable voting procedures, notice first that all voters want to raise the quota from 1 and lower it from 5. Hence, neither 1 nor 5 are self-stable. Voters 1, 2 and 3 would vote to lower if from 3 to 2 (and succeed, since they have three votes). Voters 1, 2, 3 and 4 would vote to lower it from 4 to 3, and voters 3 and 4 would vote to raise it from 2 to 3. Thus, no rule is self-stable.

## The Performance of Partnerships Under Different Decision Rules

This section analyzes the quality of the cooperation that will arise among the partners of a transnational infrastructure project. We shall not discuss the characteristics of the project and how its relevance for each partner may be evaluated. Rather, we will take the view that, whatever the project is, it is complex enough that its implementation will take time, and that many partial issues will arise during the execution stage. Any complex project (building infrastructure, operating a common facility, gradually integrating parts of different economic systems, etc.) entails many changes in the initial blueprint, however detailed this blueprint was. Its implementation often requires that each partner perform a part of the task, and this will frequently generate discrepancies regarding the causes of delays or other imperfections in the degree of compliance with these different duties. These and other issues will arise, and conflicts of interest will have to be solved through negotiation. Sometimes, the partners will have to vote on issues. In other cases, partners will try to settle their differences without needing to resort to a vote. But the voting rule looms in the background, even when it is not used, as a threat or as a guarantee. This is why we want to compare the expected performance of similar partnerships, facing a sequence of potential disagreements on how to proceed, depending on the rules that they have adopted. And we also want to know whether it makes sense for partnerships that expect to face quite different sequences of choices to choose different rules accordingly.

We shall concentrate on two aspects of the performance of partnerships, according to the decision rules that they have favored. The first aspect will be the ability to implement change. Specifically, we shall discuss whether it is true that rules close to unanimity make it harder than simple majority for the partnership to make progress. The second aspect will be the

tendency of agents to form coalitions and to engage in vote-trading, depending on the rules to be used.<sup>6</sup>

The first issue we want to discuss is the impact of different decision rules on the ease with which new proposals can be enacted. Some partnerships opt for the unanimity rule, and this means that changes upon the status quo at any point require the complete agreement of all partners. A leading example is the European Union, which requires unanimity of all the member states in order to adopt changes. There is no doubt that a unanimous rule, by giving veto power to all partners, makes it hard to introduce changes. New proposals for improvement must be agreed upon by everyone, decisions arbitrating between conflicting views easily fall into stalemate, and so on. This explains a growing consensus among many EU leaders that a well functioning partnership may want to use the rule of simple majority or, at any rate, some qualified majority far from unanimity, in order to expedite common business.

Without going as far as defending the use of the unanimity rule, it will be worth pointing at several reasons why the dynamic aspect of a partnership may affect our initial intuitions regarding the connection between the ease with which change can be made and the type of voting rule used. Clearly, if we consider a one-shot relationship between agents who must make one single common decision, changes are easier to adopt under rules that require a

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<sup>6</sup> A third aspect, having to do with the ability of rules to take into account the views of the citizens of each country, is the issue of legitimacy. Rules should be such that all citizens feel sufficiently represented. This has to do with the possibility that different countries get different voting weights, which is briefly mentioned in Section 6.

smaller number of approvals for change. Notice, however, that partnerships have a long life ahead, if they form, and that many different issues will arise for a vote. Thus, the choice of rule may have additional effects, in at least two directions.

First, the choice of rule may affect the likelihood of acceptance to form the partnership. Veto power is a guarantee that others will not easily overrule the proposals of one partner, and some potential participants may, in fact, shy away unless given a guarantee in the form of rules that require high levels of consensus in order to make new decisions. It may be that rules involving less veto power for partners become increasingly acceptable to the extent that past experience induces mutual trust. But it is clear that most partners will demand some guarantees. This is one reason why low majority requirements may work against actual decision making.

Second, a small majority may sometimes slow down the adoption of new projects, if partners foresee that they can fall too easily into a minority and become unable to redress the decisions made by others. Notice that, in our previous discussion, we were not too explicit about the origin of the proposals to be faced by the partnership. In practice, many proposals are only advanced if they have a good chance of being passed, and their presentation on the floor comes only after substantial preparation. But even then, many of the proposals that a partnership will face are only rough plans, to

be developed into detail through a number of further decisions. Suppose, for example, that a new long-term project is presented, and that some majority  $s$  is required to pass it. It is not clear if it will pass more easily if a larger majority  $s'$  is required. If the course of action to be taken in the future will be gradually determined by future decisions, I may require quite a bit of veto power before even accepting to start the process. My voting attitude today may be much more generous if I know that my voting power in the future guarantees that I will be able to avoid decisions that I consider wrong. So, starting a new project by an already existing partnership may become more likely under a high majority system than a lower one, contrary to initial intuition.

We have seen before that simple majority is the only rule that maximizes the global utility of partners. However, simple majority as well as other voting systems, are subject to coalitional manipulations through vote trading that may lower their degree of collective efficiency. It is important to be aware of these possibilities when assessing the performance of different vote rules: some rules that appear to be more efficient may, in fact, turn out to be less so if they end up favoring a larger degree of logrolling. The possibilities we refer to are illustrated in the concluding remarks of Barberà and Jackson (2000), where vote trading is incorporated to the basic model we have been discussing.

## Extensions and Conclusions

This section points to some extensions and improvements that would enrich our present analysis of decision rules in transnational projects or other kind of long-term partnerships.

First, it would be interesting to include an explicit analysis of the process for agenda formation, that is, which type of modifications will finally be submitted for consideration. It is well known that many international organizations as well as other types of committees, prefer to look for large consensus, and only use the possibility of a decision by a short margin as a threat or as a last resort. The model presented in this article is sufficient to encompass some essential features in constitutional choice: the fact that voting methods should be useful for any type of unexpected contingencies, and regardless of the position of the different partners about each one. However, the model does not permit an analysis of the cases in which the agenda depends upon partner preferences. For instance, the model is not appropriate for decision making when some proposals might not be presented for a vote, even if they might win by a narrow margin; instead, partners may keep iterating their agenda proposals in order to achieve higher levels of support for the final decisions. Including these cases in the analysis would require a model of agenda formation.

A second extension would require assuming that the preferences of agents for different issues are more complex than they are in the model discussed here. On the one hand, we could distinguish among different types of issues according to their importance for the partners. In our model, all partners get one unit of utility when their preferred proposal (change or no change) is adopted, and zero otherwise. It is conceivable that each partner finds some issues more important than others, and also that different partners disagree on what is really crucial. This opens the door for several rules (instead of one): it might be that

larger majorities are preferred by all agents for issues that they all agree are more important, with smaller majorities required for lesser issues. New possibilities for vote trading would arise in case of disagreement, with partners giving in on those issues that they deem less important, in exchange for votes when they really care. One possible way to avoid such strategic interchanges of votes is by simply letting individuals trade votes among themselves, over different periods: give each agent a vote per decision, but let her store the vote if it is unimportant and use several votes on issues that she really cares about. This is the idea of storable votes, recently proposed by Cassella (2001).

A third extension could be including complementary decisions in the model. In a dynamic context, winning on some votes may be irrelevant unless victory also comes in others. If a large project requires financing for five years in a row, getting funds for three years and not for the other two is by no means equivalent to having success in three-fifths of the cases! The need to have combinations of bills passed, rather than single ones, may introduce important qualifications in our analysis of the dynamic consequences of special majority rules.

A last extension that is very useful for transnational projects consists on having partners with different numbers of votes. We have carried out all the analysis under the assumption that each partner has one vote. This assumption is justified in many cases where partners have the same status, or put the same resources at stake. But in infrastructure projects financed and developed by the private sector, the numbers of votes depend upon equity participation. In most country partnerships, larger countries get a larger share of the vote, but that share is substantially smaller than what would correspond to them by population size. At any rate, different weights will definitely alter some of

the results we expressed above, but not their spirit.

We have mentioned these possible extensions in order to point at potential complications in the analysis of voting rules. But the basic mes-

sage does not need them. What is important is to realize that decisions rules, once adopted, influence the course of action taken by partnerships, and should therefore be the object of careful debate and negotiation.

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# APPENDIX

## The Useful Enemy

This appendix provides an example of the strategic behavior that arises when even one vote is sufficient for new entries in a partnership. The example is taken from Barberà, Maschler and Shalev (2001).

Consider a society already made up of a set of members (the founders), facing the possibility of incorporating new members during a number of periods. In our example there is only one founder,  $a$ , and twelve candidates

- $b_1, b_2, b_3, b_4, b_5, c_1, c_2, c_3, c_4, c_5, d$ , and  $e$

Candidates may be admitted at any one of 4 periods, after a vote. In our example, each member of society (that is, the founder, plus whatever candidate has been admitted in previous periods, can vote for as many candidates as desired. All candidates that receive one or more votes are admitted, and can vote for the remaining periods. Once elected, no one can be expelled. The founder and the candidates as well, get utility for the time that they belong to the society. Their utility is the sum of utilities received from sharing the society with other members, calculated as follows. If an agent likes another, he gets one unit of utility per period they share as members. If an agent dislikes another, he gets  $-1-\epsilon$  units of utility per period (with  $\epsilon$  a small number, enough to make the union of a friend and an enemy be less desirable than having none). The list of friends and enemies of these different agents is the following:

- $a$  likes  $b_1, b_2, b_3, b_4, b_5$ , and no one else.
- $b_i$  likes  $c_i$ , and no one else, for  $i=1, \dots, 5$
- $c_i$  like  $d$ , and no one else, for  $i=1, \dots, 5$
- $d$  likes  $e$ , and no one else
- $e$  likes nobody

Notice that, in this example and in other similar situations, voting for a friend is not always optimal, if this friend might eventually vote for other undesirable candidates. Hence, the election of friends may be postponed up to the last period, when their future votes are no longer a possible threat, or at least delayed for a few periods. Also notice that no agent has an incentive to vote for someone else with the purpose of a future alliance to elect others, since each voter has enough power to elect any candidate, just with one vote. Hence, one may suspect that there are no circumstances where voting for an enemy makes sense. Yet, our example shows that such cases may arise, as the result of the possible deterrent effect that this enemy may have on the voting behavior of other members of society.

To see that, we argue that the following strategy profile is a (subgame perfect) equilibrium of the game induced by the above voting rules. An equilibrium profile:

- If elected at any period,  $e$  votes for no one
- If elected at any period,  $d$  votes for  $e$  in the following period
- If elected at the period before last, any  $c_i$  votes for his friend  $d$  in the last. If elected before, he will vote for  $d$  immediately provided  $e$  is already in the club. Otherwise, he will wait till the last period, and then vote for  $d$ .
- If elected at the period before last, any  $b_i$  will vote for his friend  $c_i$  in the last period. If elected with two periods ahead, he will immediately vote for  $c_i$  only if  $d$  is already in the society. Otherwise, he will wait to vote for  $c_i$  in the last period.
- If already a member of society with three periods ahead,  $b_i$  will vote for  $c_i$  if  $d$  is already in, or else if  $e$  is not in. Otherwise, he will postpone his vote for  $c_i$ .



- The founder votes for all the  $b$ 's and for  $e$  in the first period.

This is an equilibrium, and when played, it results in agents of type  $b$  postponing their support for the  $c$ 's until the last round of vote. The founder will find it advantageous to include his enemy  $e$  because the presence of this agent prevents the  $b$ 's from voting early in favor of the  $c$ 's, whom the founder dislikes. Candidate  $e$  is the useful enemy, worth bringing in at an early stage.